Gryllacrididae (Orthoptera: Ensifera) in southern Africa

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Abstract

Although Gryllacrididae are a largely southern hemisphere insect family, they are relatively poorly represented in southern Africa, with three genera (*Ametroides* Karny, 1928, *Glomeremus* Karny, 1937, and *Stictogryllacris* Karny, 1937) and ten species and subspecies recorded from the region. All *Ametroides* and *Glomeremus* species are wingless while those of *Stictogryllacris* are long-winged. All species are arboreal and nocturnal, returning by day to characteristically silk-spun shelters between leaves. Here, we present a diagnosis, key to genera, and high-quality images to assist in identification of Gryllacrididae. By compiling all published information in one place, we hope to facilitate future researchers to investigate this poorly known group.

Key words

aptery, diagnosis, genera, macroptery, Stenopelmatoidea, silk production, taxonomic key

Introduction

Gryllacrididae (leaf-rolling or raspy crickets) are a cosmopolitan, though largely southern hemisphere (about one-third of the world's 600-odd species are known from Australia; Rentz 1997), family of Stenopelmatoidea with only a few representatives in southern Africa. But since the group is poorly studied there, having been last revised by Karny (1929), the fauna is quite likely to be significantly richer than assumed. Three genera with a total of ten species and subspecies have been recorded from the region.

Gryllacridids are robust, non-jumping crickets with stout, spiny legs. The exceptionally long antennae are rolled or curled around the body when the cricket is at rest (Figs 1–2). The southern African species are medium-sized (adults about 15 mm long), pale brown with soft bodies. *Ametroides* Karny, 1928 and *Glomeremus* Karny, 1937 (Figs 1–3) species are totally wingless while *Stictogryllacris* Karny, 1937 species have long tegmina and functional hind wings (Figs 4–5). Mature females have an ovipositor of roughly body-length (Figs 2, 5). In *Stictogryllacris* the tegmina are about twice the length of the abdomen and protrude a considerable distance beyond the tip of the body (Figs 4–5). As far as is known, all southern African species are arboreal and nocturnal and build shelters by spinning leaves together; elsewhere soil-burrowing species are known in which the silk is used to stabilize the surrounding soil (Morton and Rentz 1983). Gryllacridids produce often loud sounds (the origin of the common name "raspy crickets" coined by Rentz (1996), specifically for Australian species) either during defensive displays or while drumming on the substrate in intra-specific communication. Sound is produced by rubbing spines on abdominal tergites against tubercles on the inner surface of the hind legs (Field and Bailey 1997). All species lack tympana so sound communication is via surface vibration.

Silk-production has evolved at least 23 times in 17 orders of insects (Sutherland et al. 2010), sometimes multiple times in larger orders (twice in Neuroptera, twice in Coleoptera, three times in Diptera, and six times in Hymenoptera). Silk production has apparently evolved three times in Orthoptera: twice in different clades of Anostostomatidae – once in *Lezina* Walker, 1869 species, which occur in southwestern Asia and in northern and northeastern Africa, and once in *Cnemotettix* Caudell, 1916 of western North America (Vandergast et al. 2017) – and in Gryllacrididae where it is universal, and clearly monophyletic (Walker et al. 2012, Vandergast et al. 2017). Although silk is used during some stage of the life-cycle of all of these insect groups, in most it is produced only during a short-lived process or during only one life-stage. In only two orders, Embioptera and Orthoptera, however, is silk produced throughout the life-cycle of its members.

Members of the Gryllacrididae have certain unusual and unique characteristics, the foremost of which is the ability to produce silk, while another, recorded in some *Glomeremus*, is that they feed on nectar which is imbibed through a network of special maxillary microtrichiae that connect the maxilla and mandibles by capillary tubes. This adaptation essentially deviates from the typical biting and chewing mouthparts in Orthoptera to function-

ally one of sucking or fluid-feeding (Hugel et al. 2010, Krenn et al. 2016). Due to this adaptation to nectar-feeding, one species of Gryllacrididae from La Réunion in the Mascarene Islands, *Glomeremus orchidophilus* Hugel et al., 2010, evolved to become the only known orthopteran pollinator (Micheneau et al. 2010).

Silk is produced in one of three positions on the insect body: in the labium (as modified "salivary" glands), Malpighian tubules, or in a variety of dermal glands. The latter include silk-secreting accessory sex glands. Labial glands account for most examples of silk-production in insects such as the ubiquitous silk-spinning in Lepidoptera larvae. Dermal glands follow in terms of frequency of occurrence, while the production of silk by Malpighian tubules is rare (Sutherland et al. 2010). Examples of dermal gland production are found in Embioptera of all stages and ages in which the glands are situated in the prothoracic tarsomeres. The main function of the silk is for lining residence tunnels amongst debris and under bark where they live. Sexual accessory glands as are found in male Archaeognatha Börner, 1904 and Zygentoma Börner, 1904, function to spin silken threads that lead females to a spermatophore or silken mats on which spermatophores are deposited. The most familiar examples of Malpighian tubules producing silk are known from Neuroptera larvae, all of which spin pupal cocoons with silk.

Gryllacridids of both sexes are capable of spinning silk from soon after hatching until they die and the function is exclusively for construction of day-time shelters. These may be completed within 24 hours and are returned to repeatedly unless damaged, apparently by following pheromone trails. Crickets seal themselves into the shelters by closing the entrance with a silken flap through which they cut an access hole with the mandibles to enable them to emerge to forage. This is done repeatedly after every emergence and return to the shelter. Adjacent leaves may be pulled together and held with the tarsi while they are spun together (Fig. 6). The shelters are thought to function mainly in anti-predator defense, although in soil-frequenting species in arid regions, protection against desiccation is presumed (Walker et al. 2012). Most species are omnivorous although predation of sessile insects and spiders has been recorded (Hale and Rentz 2001).

The diameter of each silk strand produced increases with age – in the Australian species, *Apotrechus illawarra* Rentz, 1990, the diameter of a strand increases threefold between early and late instar crickets (Walker et al. 2012). Silk strands are produced by the labial glands from which a droplet of fluid issues and is formed when the labium is touched against the substrate then drawn away from the droplet (Figs 7–8). Single strands are spun from one substrate and attached to another. This is done repeatedly, resulting in thicker fibers, or individual strands are added together or crossed to form a film. Where fibers touch, they stick together, eventually forming a mat. Silk is added to the existing mats over time until the inside of the shelter is more or less covered in silk sheets (Walker et al. 2012; see Fig. 1).

In this short communication, we review the limited information available regarding southern African Gryllacrididae in the hopes that future researchers will be encouraged to study this elusive, but fascinating, group. We present a key and images to genera found in southern Africa, which will hopefully assist in future identifications of southern African Gryllacrididae.

Methods

Detailed photographs illustrating elusive Gryllacrididae behaviors were taken by H. de Klerk opportunistically from 1985–2017 during his hiking trips throughout southern Africa's natural areas using predominantly Nikon equipment. Most Gryllacrididae were encountered at night by carefully surveying surrounding vegetation until movement of antennae was observed and an individual was spotted. All images were taken *in situ* with either a 105 mm or a 200 mm Nikkor macro lens with flash illumination using multiple flashes.

Results and discussion

Diagnosis of southern African Gryllacrididae.—Gryllacrididae are most easily confused with Stenopelmatidae but do form a distinct monophyletic clade (Vandergast et al. 2017). Southern African Stenopelmatidae tend to be more robust in appearance and have shorter and thicker antennae than southern African Gryllacrididae. Gryllacridids are characterized by depressed and soft tarsi with prominent lateral lobes (Hale and Rentz 2001). Female stenopelmatids have reduced, flap-like ovipositors (see Weissman and Bazelet 2013, fig. 7), whereas southern African Gryllacrididae have long, sword-like ovipositors typical of Ensifera. Adult male Stenopelmatidae have lateral hooks on the anal plate (tenth tergite + epiproct, see Weissman and Bazelet 2013, fig. 6), while Gryllacrididae males

Fig. 1. *Glomeremus* sp. 1. From the Drakensberg, South Africa, illustrating the long, curled antennae and the silk matting on the inner surface of the leaf shelter. Body length about 15 mm.

Fig. 2. *Glomeremus* sp. 2. From the mountains of the southwestern Cape Province, South Africa. Body length about 15 mm.

Fig. 3. *Glomeremus* sp. 3. A mating pair from the southwestern Cape Province, South Africa. The female is on top, the male below her. Spermatophores, produced by the male during copulation, and characteristic of Ensifera, are clearly visible. Body length about 15 mm. Photo by C. S. Bazelet.

Fig. 4. *Stictogryllacris lyrata* from the northern face of the Soutpansberg range in South Africa. Body length about 15 mm.

Fig. 5. *Stictogryllacris* sp. (*lyrata*?) from Highveld riverine habitat in Malolotja Nature Reserve, Eswatini (Swaziland). Body length about 15 mm.

Fig. 6. The same individual as in Fig. 5; grasping two leaves with fore tarsi and pulling them together while attaching them with silk strands.

have an enlarged ninth tergite at their abdominal apex (Gorochov 2001). All southern African Stenopelmatidae are obligatorily apterous, while Gryllacrididae can be either macropterous or apterous, depending on the species. Gryllacrididae have mouthparts specially adapted for silk production, which include well-developed maxillae and labial palps with specialized structures, while Stenopelmatidae have simple chewing mouthparts with well-developed, long, but unmodified labial palps. Both gryllacridids and stenopelmatids in southern Africa may have pegs interior to the hind femur used for femoro-abdominal stridulation, and both groups lack tympana on the fore tibiae. Furthermore, gryllacridids have heart-shaped heads when viewed head-on; stenopelmatids do not.

Ametroides (no images available) is an African genus with two of the 13 species found in southern Africa – the rest are restricted to central Africa. Males and females are totally without tegmina or hind wings.

Glomeremus (Figs 1–3) is the largest gryllacridid genus in Africa, with a total of 18 species spread across sub-Saharan Africa and some Mascarene Islands. Six species and subspecies are known from southern Africa. Both sexes lack both fore- and hind wings.

Stictogryllacris (Figs 4–8) has nine species, seven from central Africa and two from southern Africa. All species are fully-winged.

Fig. 7. The same individual as in Fig. 5; spinning silk strands to secure leaves for shelter construction.

Fig. 8. The same individual as in Fig. 5; spinning silk strands to secure leaves for shelter construction.

Key to the southern African genera of Gryllacrididae; adapted from Karny (1929)

1 Tegmina and wings fully developed... *Stictogryllacris* Karny (Figs 4–5)

– Tegmina and wings totally absent 2

2 Fore and middle tibiae with 3 to 4 spines on either side (the apical spines excepted).....................................*Glomeremus* Karny (Figs 1–3)

– Fore and middle tibiae with only 2 spines on either side (the apical spines excepted)...*Ametroides* Karny

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